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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

This Issue

DISPOSAL OF SPENT SOLUBLE OIL EMULSIONS

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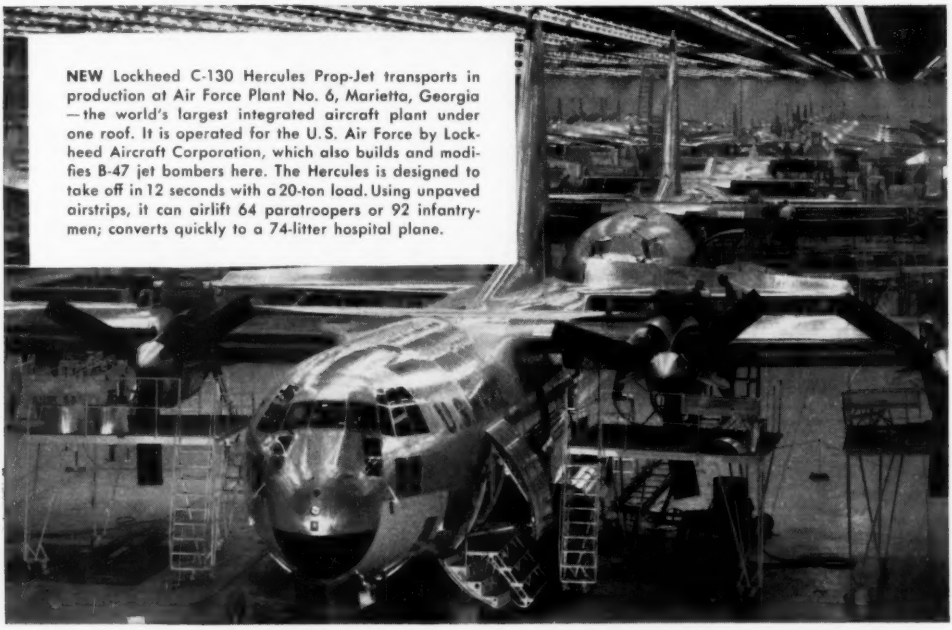

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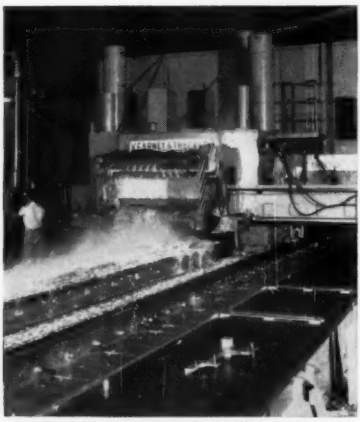

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LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

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Disposal of Spent Soluble Oil Emulsions

THE POLLUTION of public waters has become a matter of great general concern and laws regulating the quantity and quality of waste material routed to rivers, lakes and streams are becoming increasingly more rigid. The disposal of industrial waste has always been more or less a serious problem, the magnitude of which varies from plant to plant, depending upon the nature and amount of material that must be discarded. However, in certain areas at least, the problem is now becoming critical. The oil content of industrial waste streams is receiving special attention, and maximum allowable concentrations of oil continue to be drastically reduced. For example, one industrial city now requires that the daily average amount of any grease or oil in the overall waste stream from a given plant must not exceed 25 ppm, and the amount for any one day must not exceed 100 ppm.

In many plants, a large portion of the oil in their waste streams results from the inclusion of spent soluble oil emulsions. This complicates the disposal problem, since most consumers of soluble oils have little opportunity to learn about their composition and hence are more or less at a loss to decide on the best means for handling the spent emulsion. Actually, soluble oils vary over wide ranges of properties and compositions, and the emulsions prepared therefrom vary equally as widely in their stability characteristics or the ease with which they can be broken. In some instances, spent soluble oil emulsions are handled apart from the rest of the industrial waste. In other instances, such segregation is not or cannot be done. This complicates the problem since the overall waste stream will be an everchanging, complex mixture containing coolants of all types, cutting oils, lubricating oils, chemicals, dirt, and other contaminating materials.

One thing certain is that the disposal of industrial waste is a problem involving too many factors and variables to be solved by any one stock scheme or procedure. There is a great variety of methods which can be and are being used. A method ideally suited for handling the waste at one particular plant may be neither economical nor effective at another location. Consequently, the handling of industrial waste must be considered as a specific problem by each individual plant concerned. Production is of prime importance in any plant, of course, and the handling of industrial waste must interfere with this as little as possible.

REDUCE CONTAMINATION

Before even considering the type of disposal facilities to be employed, a concerted effort should be made to prevent tramp oil, from leaking machines or floor washings, from getting into the

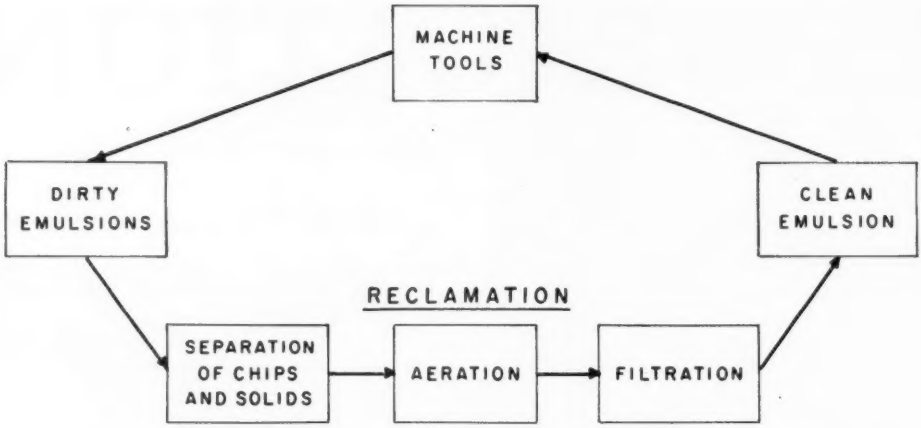

Figure 1 — Schematic diagram of steps involved in keeping emulsions clean for continuous use.

overall waste stream. It is much easier to dispose of used oils before, rather than after, they get into the waste stream. Anything that can be done in this regard will, in most cases, ease the load on the treating facilities. The overall economy of such preventive maintenance has been proved over and over again.

SEGREGATE WASTE

Perhaps the first step in planning the actual disposal facilities to be employed should be a consideration of the possibility of segregating the overall waste stream so that the quantity of material which must be given special attention can be reduced to an absolute minimum. For example, some plants find it convenient to divide their sewage into three separate streams, as follows: (1) a storm sewage stream containing, among other things, cooling water, and roofing and yard drainages, all of which can be routed directly to the public waterways; (2) a sanitary sewage stream containing the effluent from washrooms, cafeterias, and chemical laboratories, which is transmitted directly to the city sewage treatment plant; and (3) a stream containing all other wastes, including spent soluble oil emulsions. This latter stream will usually require special handling to reduce the concentration of undesirable components before it can be allowed to join the storm sewage stream and proceed to the public waterways. In some cases it may even be advisable to subdivide this third stream still further so that the spent soluble oil emulsions can be handled by themselves. In any event, anything that can be done to reduce the amount of material that must actually be treated will be highly desirable. Every plant faced with a waste disposal problem should consider taking whatever steps they can to reduce this quantity.

HANDLING SPENT EMULSIONS

The particular method to be used for handling that portion of the overall waste material which requires special treatment will depend to a great extent upon both the geographical space limitations and the overall amount of material to be treated. Simple lagooning can be employed successfully in most cases if sufficient space is available. More elaborate skimmers and separators become necessary to speed up oil separation and water clarification as the ratio of the available space to the amount of material to be treated decreases. When lagooning cannot be used, chemical treatment of some sort is almost mandatory. In cases where the volume of waste material to be treated is exceptionally large and the treating space very small, special equipment can be used in conjunction with chemical treatment.

Some procedures and methods currently being employed by industry to handle spent soluble oil emulsions and wastes containing spent emulsions are outlined briefly in the following sections. These are not to be regarded as complete or detailed descriptions but are intended only to serve as guides and to suggest general approaches that may be considered for any plant where waste disposal is a problem. Modifications can readily be developed by the particular plant concerned to adopt any one of these general schemes to its own specific needs.

Reclamation of Emulsions

Often through careful and controlled handling, it should be possible to maintain the condition of

soluble oil emulsions in such a state that they need never be discarded, thereby eliminating the problems associated with their disposal. Obviously, a number of factors are involved in determining the relative merits and economics either of keeping the emulsion in such good condition that it never has to be removed from service, or of allowing the emulsion to become spent and subsequently handling its disposal so as to conform to legal requirements. Such factors include, among others, the nature of the machining operations, the quantity of emulsion in use, the amount of contamination and whether this contamination is inherent in the machining operation itself, or whether it is of external origin. Of all the factors to be considered, perhaps the contamination element is the most important. If the emulsion is to be kept indefinitely, contamination must be reduced to an absolute minimum. Not only does excessive contamination complicate the handling necessary to keep the emulsion in condition for continuous use, but also contamination can eventually promote the breakdown or separation of an emulsion. Leakage of the machine tool lubricating oil is one of the most common and likewise undesirable sources of contamination of a soluble oil emulsion. This is most prevalent in old machine tools which have been in service for a long time and is probably the most difficult source of contamination to eliminate. Contamination resulting from bad housekeeping practices can usually be prevented more easily.

Generally, three main steps are involved in the reclamation of spent soluble oil emulsions, namely, (1) separation of metal chips and other solid particles, (2) aeration, and (3) filtration. Separation of solid particles can be accomplished by gravity settling, although the use of magnetic separators may be helpful in some cases. If the emulsion has been used for grinding operations, there undoubtedly will be some grinding dirt which will float on the surface of the emulsion. This can be skimmed from the surface in the settling stage. Aeration of the emulsion will bring to the surface any tramp or non-emulsified oil, which can then be removed. Aeration will also be effective in killing any growth of bacteria which may have developed and which, if allowed to persist, will eventually cause the emulsion to break. Filtration may not always be necessary, but it is recommended to remove the last traces of any finely divided metal particles still present in the emulsion. There is a variety of filters available on the market which will do the job required without harming the emulsion itself.

A number of techniques can be visualized for performing the various steps involved, ranging from batchwise to continuous operation. The following is an example of a continuous scheme that might be employed in a large plant which uses a central system for distributing soluble oil emulsions.

The emulsions could be transferred from the individual machine tools to the treating area by means of suitable pipes, troughs or ditches, care being taken to avoid further contamination during transfer. As a precautionary measure, it is recommended that the ditches or troughs be covered. The emulsion then enters the bottom of a sump or settling basin for gravity separation of the solid particles. The hold-up time should be sufficient to

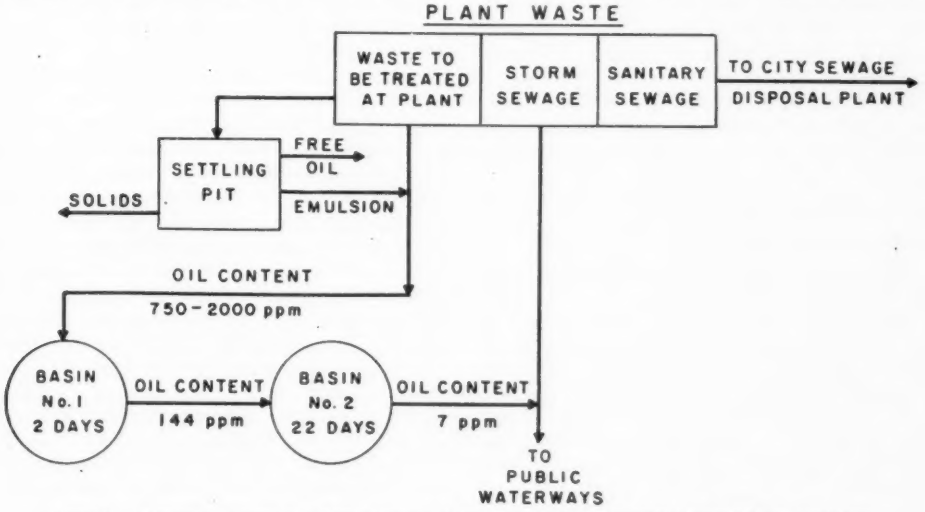

Figure 2 — Schematic diagram of a physical means of handling plant wastes containing soluble oil emulsions.

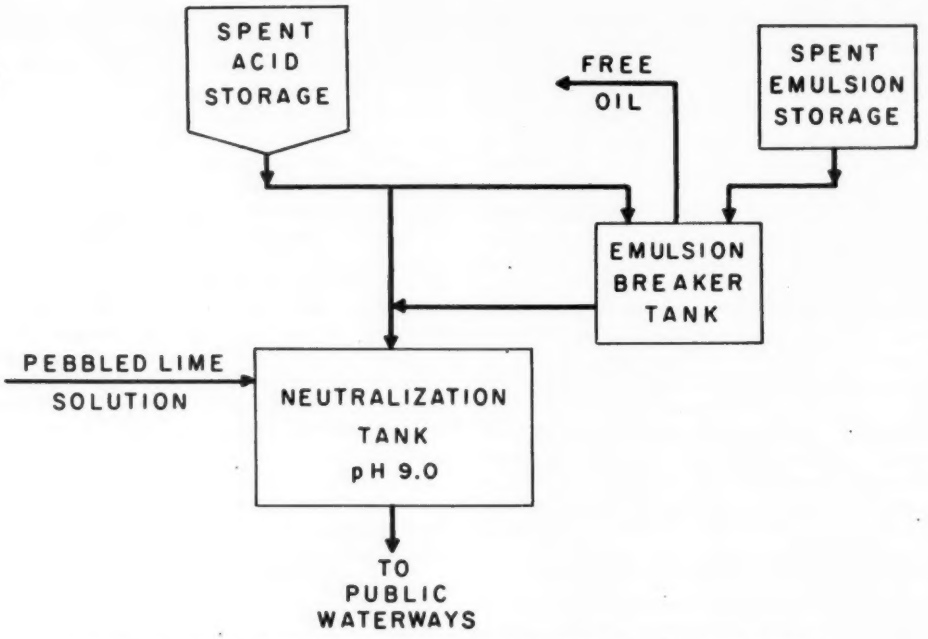

Figure 3 — Schematic diagram of method of treating spent soluble oil emulsions and spent acid.

permit complete separation of all the material that will settle out. Metal chips can be removed from the bottom of the sump by means of a mechanical conveyor. Any grinding dirt floating on the surface can be removed by directing a jet of air across the surface and blowing the dirt to one end where it can be picked up by the chip conveyor. The emulsion is then siphoned into a tank where it is aerated to bring to the surface any non-emulsified oil and also to destroy bacteria growth. The separated oil can be skimmed or over-flowed into a trough for subsequent handling. The clean emulsion is pumped through a suitable filter to a central tank from whence it is redistributed to the individual machines as needed.

Physical Means for Disposing of Spent Emulsions

Almost all strictly physical methods of handling spent soluble oil emulsions require a certain amount of land, and handling becomes more complex as the ratio of the quantity of emulsion to the area of available land increases. As mentioned previously, the problem can be simplified to a degree by segregating the overall industrial waste stream, if possible, so that the quantity of waste material that must be given special attention is reduced to a minimum.

The theory involved in handling that portion of the waste which must be treated is relatively simple although the actual execution may be complex, depending upon the nature and amount of material to be handled. In principle, the waste may be transferred to an open area which serves as a detention basin and after due time the soluble oil emulsion will break. The oil will rise to the surface where it can be skimmed and the other impurities will either come to the surface with the oil or settle to the bottom. The hold-up time in the detention basin will have to be of sufficient length so that the water to be discarded will meet the required specifications of the particular locality.

In practice it is usually found advisable to route the spent soluble oil emulsions to a settling pit before transferring it to the detention basin. This is particularly true if the spent emulsion contains an appreciable quantity of metal chips or other solid material which, if allowed to accompany the waste to the detention basin, would gradually decrease the volume of the basin and eventually fill it up. The settling basin can be either a simple pit where solid particles can settle out and eventually be hauled to a dump, or it can be in the nature of an A.P.I. Separator which will remove not only the solid material but also any nonemulsified oil present. Whether a settling basin or some sort should be used and whether it should be a simple settling pit or an A.P.I. Separator will

depend upon the quantity of material in the waste that could be removed in this step.

As far as the detention basin or basins are concerned, the simplest case is one where the quantity of waste is so small in comparison to the volume of the basin that the waste material is simply transferred to the basin and allowed to remain there. In due time the water will evaporate and its ultimate disposition will then constitute no problem. Of course, in order to employ this particular modification there will have to be some sort of a balance between the waste input and the evaporation of the water.

In most cases, the simplified procedure can not be used because the amount of waste coming into the retention basin in a given period of time will greatly exceed the amount of water evaporated during the same interval. Hence, it will be necessary to remove clarified water from the basin. In some cases, the relative volume of waste to be handled and the volume of available land that can be used as a detention basin are such that the overall land can be used as a single detention basin, and the retention time will be sufficient to enable the clarified water to meet the necessary spcifications. In other instances, the holdup time will be insufficient for this to occur, and in such cases it will be necessary to subdivide the land into two or more retention basins operating in series. For a given area of land, its efficiency as a retention basin for clarifying waste water increases, up to a point at least, as the number of separate basins connected in series increases.

The following will serve as an example as to how one plant employs this system of lagooning to clarify their waste. The overall waste is divided into three separate streams, in accordance with previous discussion, namely a storm sewage stream which goes directly to the public waterways, a sanitary sewage stream which is transferred to the city sewage plant, and a stream containing all other wastes which must be treated at the plant. The plant operation is such that the spent soluble oil emulsions can be segregated by themselves, and they are collected and transferred to a concrete settling pit divided into three separate chambers.

The spent emulsions are dumped into the first chamber where settling of the solids and some separation of the emulsion occurs. The supernatant liquid including the separated oil is allowed to flow into the second chamber where additional settling and separation takes place. The liquid from this chamber then flows into the third section where the separated oil is removed. The clarified emulsion then joins the rest of the waste stream on its way to the first retention basin. By utilization of the settling pit, 1000 gallons of oil and two to three cubic yards per month of solids are prevented from entering the sewage line on its way to the first retention basin.

The theoretical retention time in the first basin is approximately two days. During this period, sedimentation takes place and a good portion of the oil separates and rises to the surface. The oil content of the influent to this first retention basin ranges from 750 to 2000 ppm. The oil content of the effluent averages 144 ppm.

The effluent from the first basin discharges through a siphon into a second retention basin where the theoretical detention time is 22 days. This is sufficient to reduce the oil content from the 144 ppm. to about 7 ppm., which is well below the maximum allowable content for that area.

Chemical Treatment of Wastes Containing Spent Emulsions

There are a number of chemicals that can be used to treat industrial wastes containing soluble oil emulsions, and there are a great many ways in which they can be employed, ranging from rather simple to relatively complex systems. In most cases the nature and amount of material to be treated, economic considerations, and ease of handling will dictate the chemicals to be employed and the manner in which they will be used.

The addition of an acid or a salt to a relatively clean emulsion will cause that emulsion to break, and a complete separation of oil and water is usu-

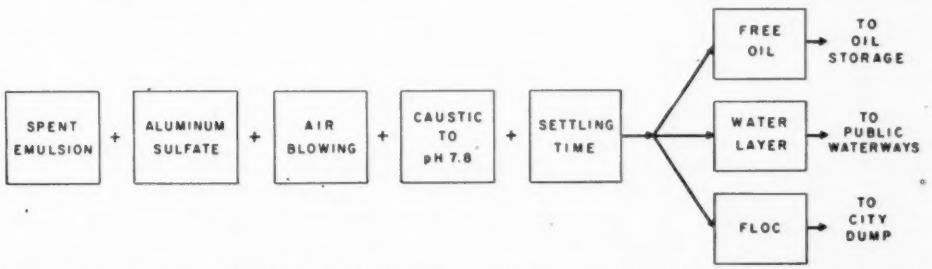

Figure 4—Schematic diagram of a batch method of treating spent soluble oil emulsions with aluminum sulfate and caustic.

ally obtained almost immediately. As the amount of contamination increases, it may become more and more difficult to completely segregate the oil from the water and even upon prolonged standing after the emulsion has been broken, the water layer may contain small amounts of dispersed oil. Experience has shown that when this occurs, the water layer can be clarified by coagulation.

This involves the formation of a precipitate which, upon settling, will take to the bottom all traces of oil and other contaminants present and leave the clarified water in a suitable condition for discharge into the public waterways. Thus, in some instances the treatment required may involve simply the addition of an acid or a salt to break the emulsion and the subsequent adjustment of the water layer to the proper pH. In other cases, a combination of emulsion breaking and coagulation will have to be used to reduce the oil content of the water to the required level. In instances where both methods have to be employed, the chemical used as the emulsion breaker should be one which also can be employed as the coagulant. For example, ferric chloride and aluminum sulfate are both efficient emulsion breakers. Upon the addition of alkali to the partially clarified water containing these salts, insoluble ferric or aluminum hydroxide is formed, both of which are good coagulants.

In order to have the most efficient operation in the chemical treatment of the wastes, it is important that the composition of the waste to be treated remain as near constant as possible from day to day. In order to approach this condition it is advisable that the waste from various parts of a plant be collected in a common storage tank prior to treating in order to allow mixing of the wastes of various compositions and thus keep fluctuations in the compositions of the overall material to a minimum. The use of settling pits should be employed of course, wherever necessary, to remove metal chips and other solid particles.

The following examples will serve to illustrate a few of the general procedures that are being used throughout industry for the chemical treatment of wastes containing soluble oil emulsions.

(1) In one plant the disposal problem consists of handling 50,000 to 60,000 gallons per day of spent acids from pickling and plating operations and about 8,500 gallons per day of a 20:1 soluble oil emulsion. Each of these materials is collected and stored separately to await treatment; the acid in a brick vat, and the emulsion in a tank. The soluble oil emulsion to be treated has been used for purposes other than as a cutting coolant and hence contains no metal chips and does not require the use of a settling pit.

The treatment is batchwise, and the spent acid is used as the emulsion breaker. The soluble oil emulsion is dumped into a brick vat and spent acid is pumped in until the emulsion breaks. Since there is excess acid available and chemical cost is not a factor, an amount of acid equal to the volume of the soluble oil in the vat is added and a complete separation of the oil is obtained. The oil is skimmed from the surface, pumped to tankage and ultimately used for road surfacing or fuel oil. The acid layer is pumped to a neutralization tank equipped with a paddle stirrer and a recording pH meter. A water solution of pebbled lime is added until the pH of the solution is about 9.0. The batch is then dumped into a large lagoon. Spent acid not used to treat the soluble oil emulsion is pumped directly to the neutralization tank and treated in the manner just described.

(2) A plant which treats spent soluble oil emulsions separately by themeselves successfully employs a combination of batchwise emulsion breaking and coagulation. Aluminum sulfate is added to the spent emulsion until the pH of the mixture is in the range of 3-4. The resulting mixture is then air blown until it is homogenous, after which caustic soda is added to a pH of 7-8. The alkaline mixture is allowed to stand and eventually separates into three layers. The bottom layer containing the floc and sludge is transferred to the city dump.

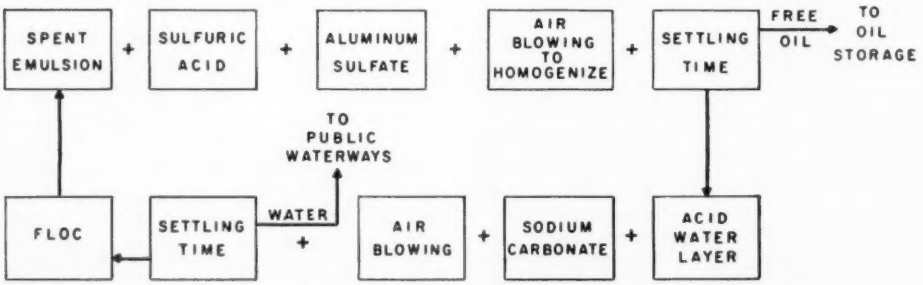

Figure 5 — Schematic diagram of a batch method of treating spent soluble oil emulsions wth sulfuric acid, aluminum sulfate and sodium carbonate.

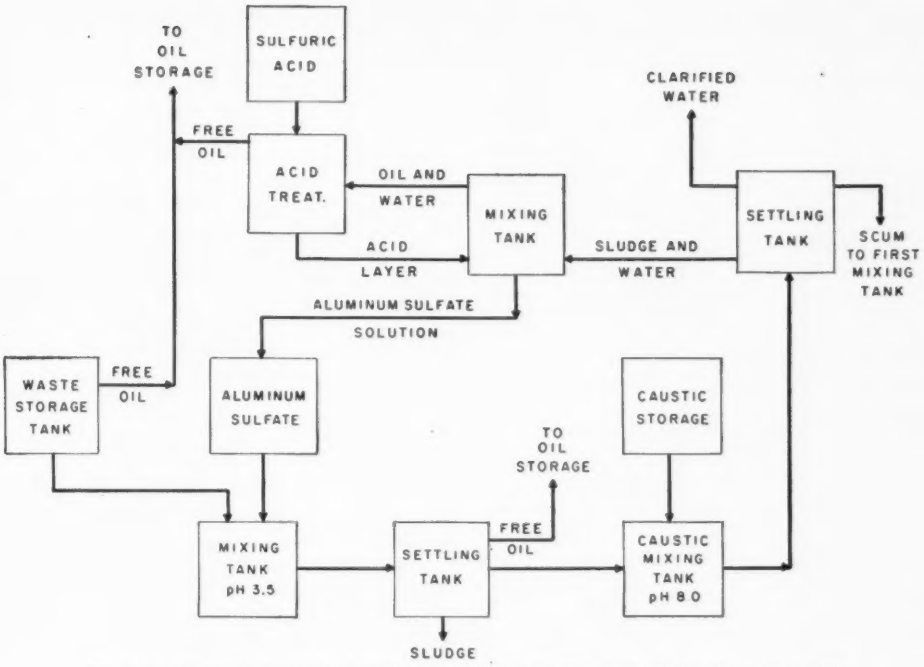

Figure 6 — Schematic diagram of a continuous method of treating spent soluble oil emulsions with aluminum sulfate, caustic and sulfuric acid.

The oil from the top layer is collected and sold to road surfacing contractors. The water layer contains 7 to 35 ppm. of oil and is satisfactory for inclusion in the sewage stream.

(3) Another plant treats 40,000 gallons per week of a 30:1 soluble oil emulsion. When the cleaning of a machine becomes necessary, the spent emulsion is transferred to the disposal plant which consists of two 10,000 gallon separating tanks, a 3,000 gallon oil storage tank, and two 400 gallon wooden chemical tanks. As the spent emulsion is brought to the disposal plant it is dumped into a shallow pit from which it runs down baffled stairways for settling out metal chips and proceeds to a sump inside the building housing the disposal facilities. The emulsion is pumped from the sump into one of the two separating tanks and calcium chloride solution from one of the chemical mixing tanks is added. Approximately 500 pounds of calcium chloride are added per 10,000 gallons of emulsion. The mixture is heated to 190°F. by means of steam coils and allowed to stand. Aluminum sulfate solution from the other chemical mixing tank is then added. About 50 pounds of aluminum sulfate is used per 10,000 gallons of emulsion. The mixture is agitated by means of a circulating pump, after which it is allowed to cool and settle. Water pumped into the bottom of the tank causes the oil layer to overflow into a gutter on the inner circumference of the tank. This oil is subsequently transferred to the oil storage tank and is ultimately sold to road contractors or burned as furnace oil. The water layer is pumped to the plant sewage stream which discharges into a river.

(4) Still another company treats some 3,000 gallons per day of a 25-40:1 emulsion batchwise in two 1,000 gallon tanks having conical bottoms. Spent emulsion is put into the first tank and about one gallon 66°Be′ commercial grade sulfuric acid is added to reduce the pH. 25 pounds of aluminum sulfate are next added as a water solution and the contents of the tank are air blown until the mixture is homogenous. The mixture is then allowed to stand until a clean break is obtained between the oil and the water. This will usually require from 15 minutes to one hour. The oil is pumped to an oil storage tank and the water layer is pumped from the bottom of this tank into the second tank. Commercial sodium carbonate is added to the second tank until the pH is in the range of 7.5 to 8.0. This will require about 25 pounds of sodium carbonate. The mixture is then subjected to mild air agitation to obtain uniformity without disruption of the floc, and is then allowed to stand until the floc completely settles to the bottom. The floc is returned to the first tank, the water is dumped to sewage, and

any oil on top is pumped to the oil storage tank. This oil is also sold to road contractors.

(5) The previous examples have dealt essentially with treatment of spent soluble oil emulsions only. This example will describe a most efficient multi-step scheme for handling about 200,000 gallons per day of overall plant sewage containing other contaminants, in addition to soluble oil emulsions. The oil content of this sewage ranges from 2,000 to 4,000 ppm. Waste from various operations throughout the plant is collected in large sumps located at appropriate locations throughout the plant. The liquid is pumped from these sumps to a 120,000 gallon storage tank located on the roof of the building which contains the equipment used in the treatment of the waste. The holdup time in this tank is sufficient to allow separation of insoluble oils, such as lubricating oils and demulsified oil.

The waste is transferred from the holding tank to the bottom of the first mixing tank which is neoprene lined and is equipped with mechanical mixers. Aluminum sulfate is added until the pH of the mixture is about 3.5. The waste is in this first tank for approximately 10 minutes.

The partially broken emulsion from the first tank is next transferred to a neoprene lined settling tank where the holdup time is approximately two hours. The bottom of the tank is divided into four hopper sections, all sloping to the same side to permit easy removal of the moderate amount of sludge which is formed. The tank is also baffled to reduce turbulence and to give semi-quiescent conditions which will permit the small globules of oil to unite and form larger bodies which will rise to the surface. The separated oil is skimmed from the top and is transferred to the oil storage tank. The effluent from the separating tank is piped into the bottom of a caustic mixing tank where 10% caustic is added until the pH of the solution is about 8.0. This tank is also equipped with mechanical stirrers. The detention time in this caustic mixer is about five minutes, after which the solution is transferred to a large steel settling tank. This tank is equipped with a flocculation chamber, a sludge pit, and a settling chamber. Clarified water overflows into a trough and goes directly to the river. Any scum on the surface of the water is skimmed and transferred to the first mixing vessel. The settled sludge is pumped to a mixing tank located on a balcony slightly higher than all of the other equipment. Sulfuric acid is added with rapid agitation to transform the aluminum hydroxide back into aluminum sulfate. This acid aluminum sulfate solution is used as the emulsion breaker in the first mixing tank. The separated oil containing a large portion of water is treated with 66°Be′ sulfuric acid. The acid layer from this step is used to treat the above mentioned sludge. The oil is heated to 240°F. to remove final traces of water and is in suitable condition for use as a furnace oil.

It may be noted from the foregoing discussion that this particular plant has several unique features in comparison with other methods of treatment. First, although aluminum sulphate is used as an emulsion breaker, only a small amount of this chemical is consumed in the process because of the recovery system. A small amount of make-up aluminum sulfate is necessary, but the chemicals consumed in quantity are the less expensive sulfuric acid and caustic soda. Caustic soda was selected as the alkali in preference to lime to avoid formation of insoluble calcium salts (which would precipitate with the floc, build up within the system, and hence eventually become a disposal problem in themselves). Secondly, the system is so designed and operated that there are no by-products or additional disposal problems. Only legally clean sewage and useful furnace oil result from the process; no road oil, sludge, etc. must be sold or hauled away. Lastly, the hydraulics of construction are such that only a minimum number of pumps is required. The liquid flows by gravity from the storage tank and through all stages of the process, since there is a six to twelve inch drop in water level between each stage. A sludge pump is required to lift the sludge to the acid treatment tank on the balcony, but even the tanks for chemicals are on the balcony, so that they may gravitate to the process tanks.

SUMMARY

Disposal of industrial wastes has become a serious problem and currently is a matter of great concern. The day has long since passed when waste from industrial plants could arbitrarily be dumped into the normal sewage outlet or routed to the nearest stream or river. Now the nature and composition of such waste material discharged to public waterways are very carefully controlled by Federal, State, and in many instances, local laws and regulations. This means that, in many cases, each plant must treat its waste material so that it will conform to legal requirements. Since the type of waste will vary greatly from plant to plant, it is apparent that the problem is an individual one and there is no one standard treating procedure which could be employed successfully by all.

The problem is complicated further when the waste material includes spent soluble oil emulsions. Since oil is one of the ingredients of plant waste whose concentration must be controlled, these emulsions must be broken so that the oil component can be separated from the water. Several general schemes for accomplishing this have been discussed which can serve as guides to those confronted with this problem.

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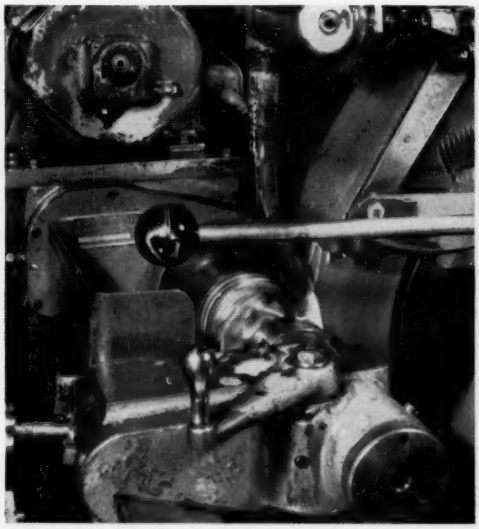
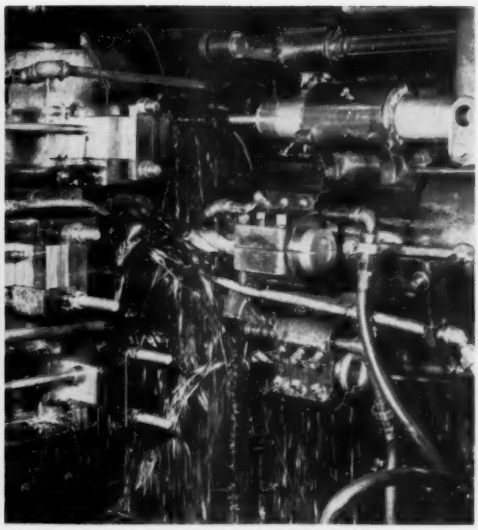
TEXACO CUTTING, GRINDING, SOLUBLE AND HYDRAULIC OILS



Grinding with Texaco Soluble Oil HW



Automatic machining with Texaco Sultex Cutting Oil

"We found out fast that Texaco does an excellent job"

Jack & Heintz, Inc., Cleveland, Ohio

"About a year ago," reports Jack & Heintz, Inc., "we tested competitive cutting fluids against the Texaco products we had been using for a number of years. We found out fast that Texaco does an excellent job.

"To cite just two examples: On our grinding operations, where precision is essential and low micro finishes necessary, we found that *Texaco Soluble Oil HW* (especially designed for hard water) gave us good rust protection and a fine finish at lean emulsion ratios. In addition, it did not load wheels and we had no odor complaints.

"In our automatic department, where we have all types of single- and multi-spindle machines and work all types of material including high alloy and stainless steels, *Texaco Sultex Cutting Oil B* gave us the good finish, long tool life and uninterrupted performance we wanted."

There is a complete line of *Texaco Cutting, Grinding and Soluble Oils* to help you do all your machining better, faster and at lower cost. Texaco Lubrication Engineering Service will gladly help you select the proper ones. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

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